Top Properties and Searches for New Physics in Top Events at the Tevatron

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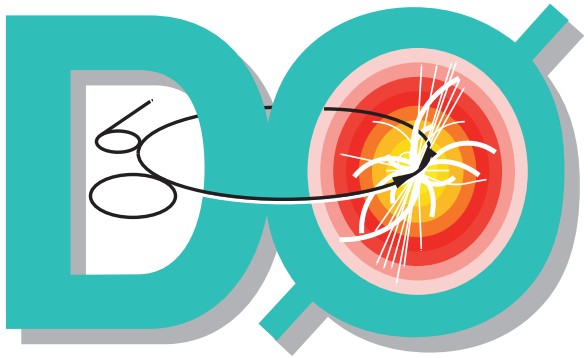
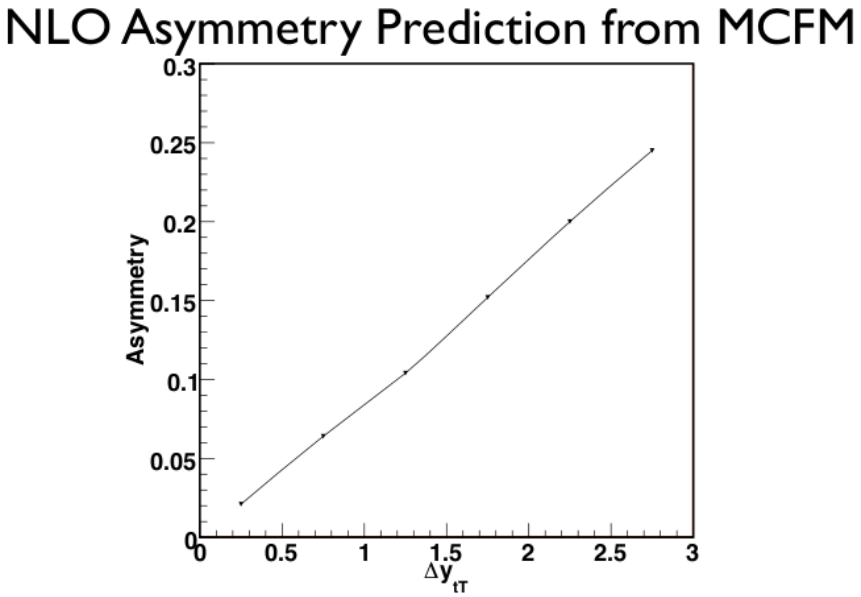
on behalf of the CDF and DØ Collaborations

Recontres de Blois
July 18, 2010



Forward-backward asymmetry in $t\bar{t}$ @ CDF

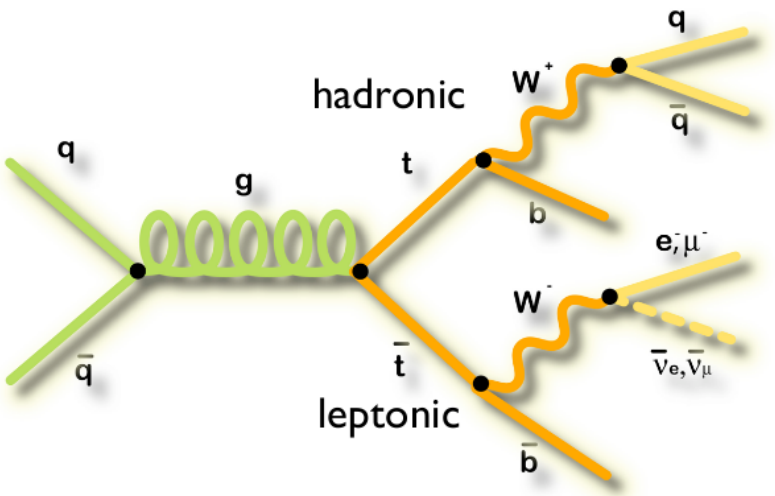


- In leading order QCD, top production is symmetric; at NLO, top quark is repelled at high rapidities by soft Coulomb field of incoming light quark, anti-top is simultaneously attracted at low rapidity
- MCFM, an NLO MC, predicts positive asymmetry at parton-level
  - A_{LAB} = 0.038 ± 0.006
  - A_{ttbar} = 0.058 ± 0.009

$$A_{FB} = \frac{N(Y > 0) - N(Y < 0)}{N(Y > 0) + N(Y < 0)}$$

Forward-backward asymmetry in $t\bar{t}$ @ CDF

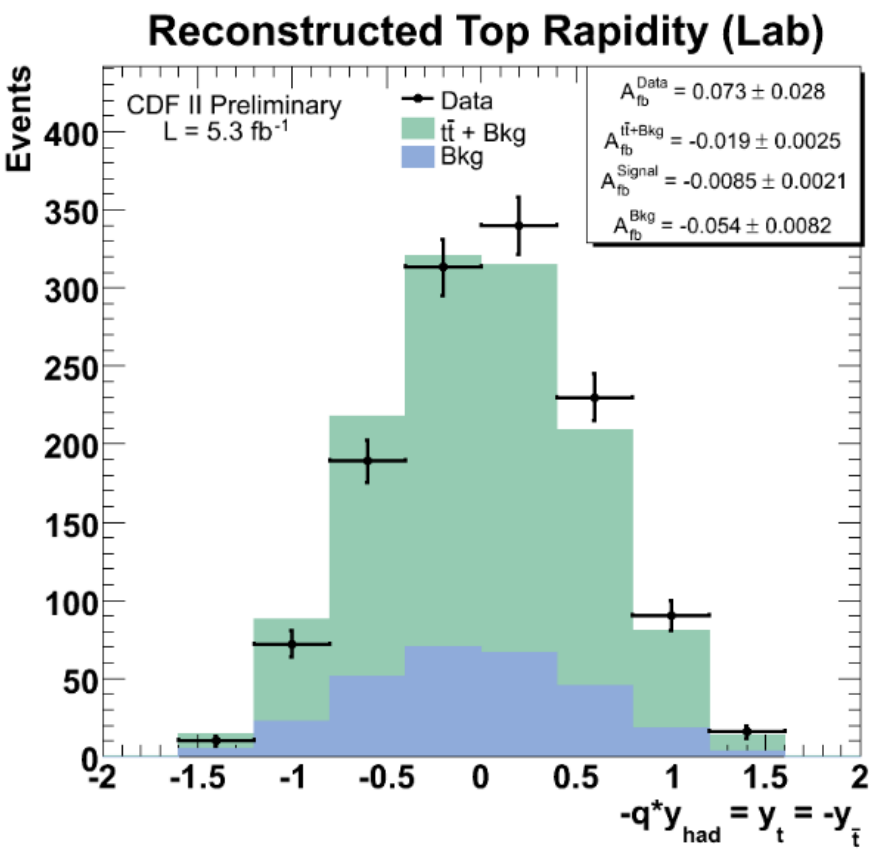
- Measure rapidity variables
- Subtract background events to extract signal
- Correct to parton-level via matrix unfold
- Calculate forward-backward asymmetry
  - inclusive
  - rapidity-dependent

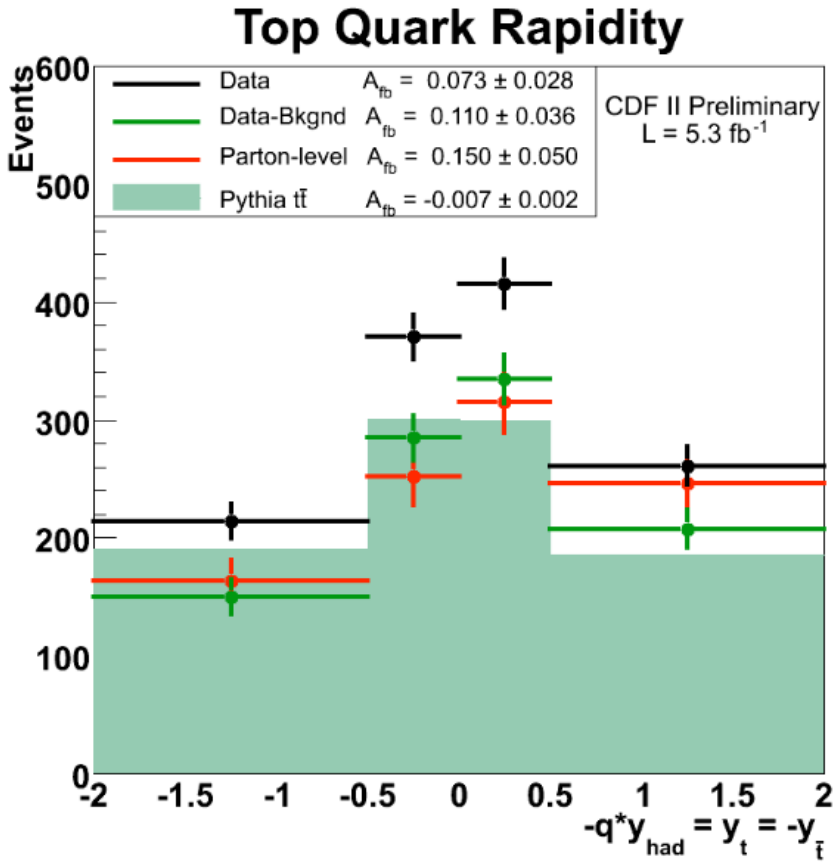


q	$t_{\rm lep}$	$t_{\rm had}$
+	t	$\bar{t}$
-	$\bar{t}$	t

$$-qY_{\rm had} = Y_t = -Y_{\bar{t}}$$
$$q(Y_{\rm lep} - Y_{\rm had}) = q\Delta Y = Y_t - Y_{\bar{t}}$$

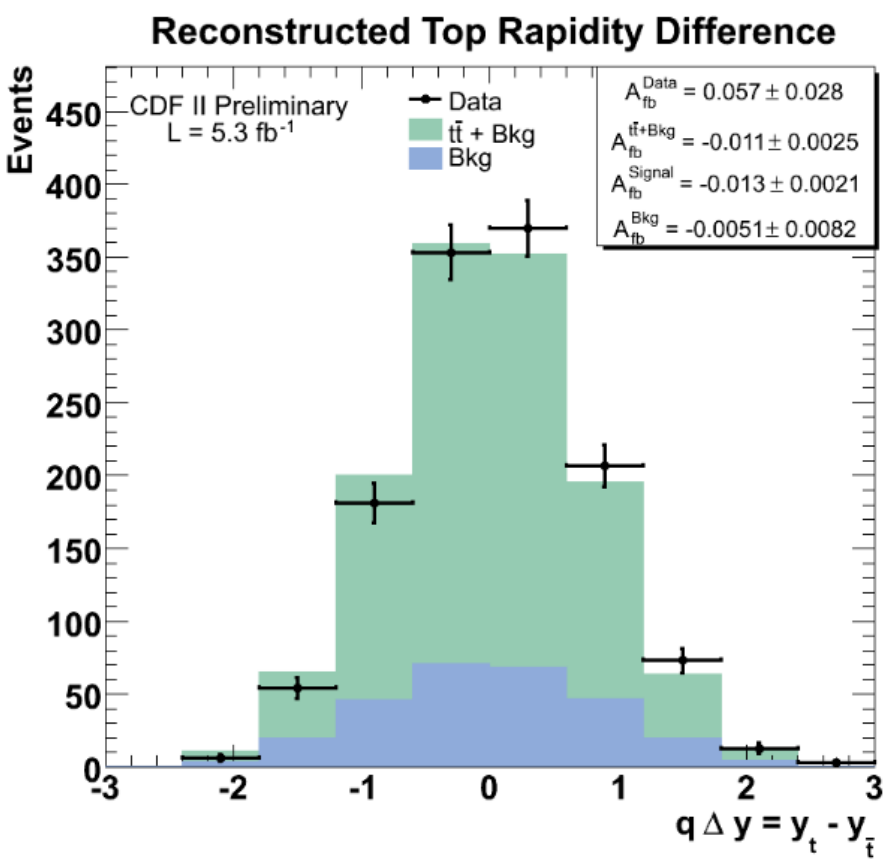
Forward-backward asymmetry in $t\bar{t}$ @ CDF

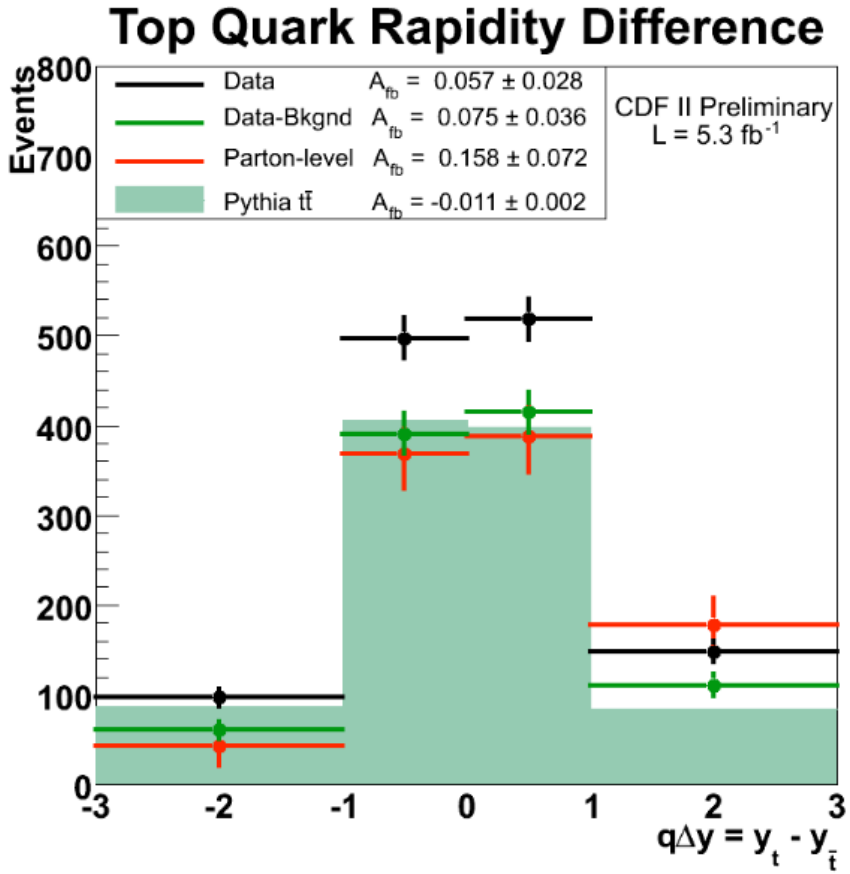




LAB Frame A_{FB}	Inclusive
Corrected	$0.150 \pm 0.050_{stat} \pm 0.024_{sys}$
MCFM Predicted	0.038 ± 0.006

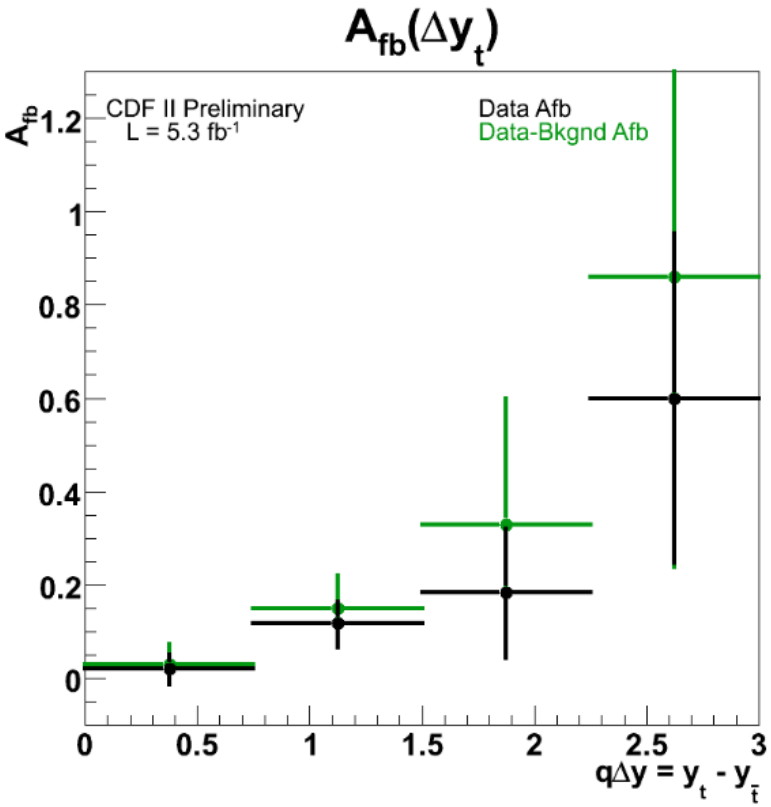
Forward-backward asymmetry in $t\bar{t}$ @ CDF

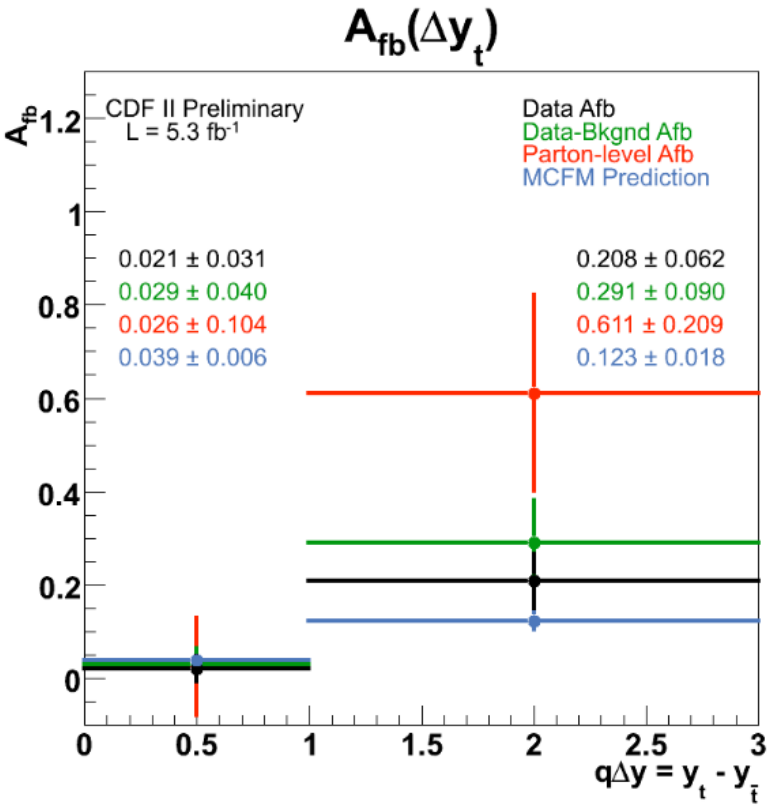




TTbar Frame A_{FB}	Inclusive
Corrected	$0.158 \pm 0.072_{stat} \pm 0.017_{sys}$
MCFM Predicted	0.058 ± 0.009

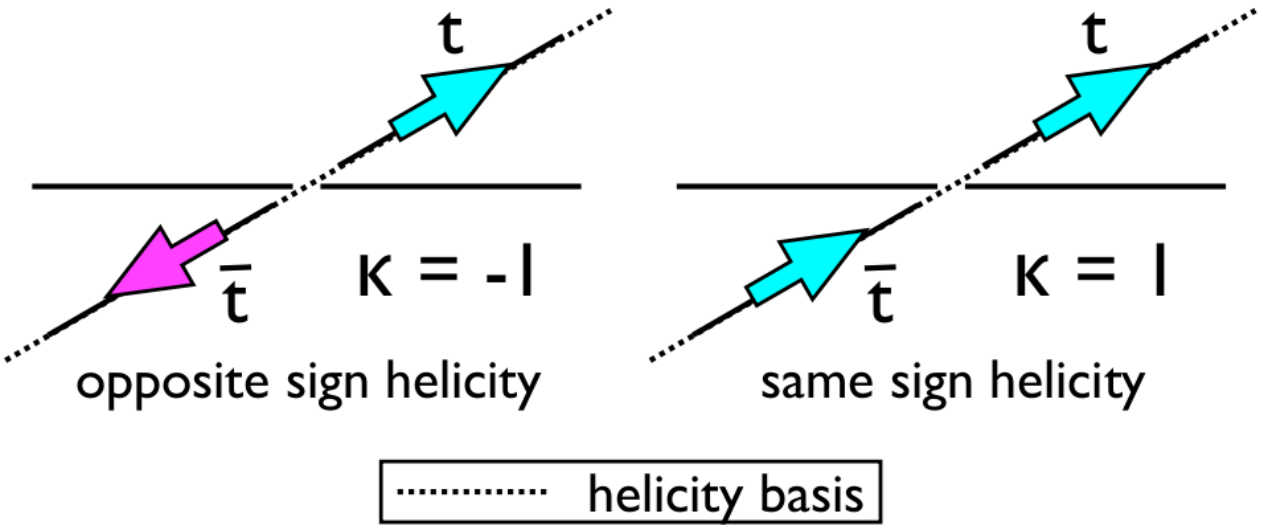
Forward-backward asymmetry in $t\bar{t}$ @ CDF





A_{FB}	Low Rapidity ($\lvert\Delta y\rvert<1$)	High Rapidity ($\lvert\Delta y\rvert>1$)
Corrected	$0.026 \pm 0.104_{stat} \pm 0.055_{sys}$	$0.611 \pm 0.210_{stat} \pm 0.141_{sys}$
MCFM Predicted	0.039 ± 0.006	0.123 ± 0.018

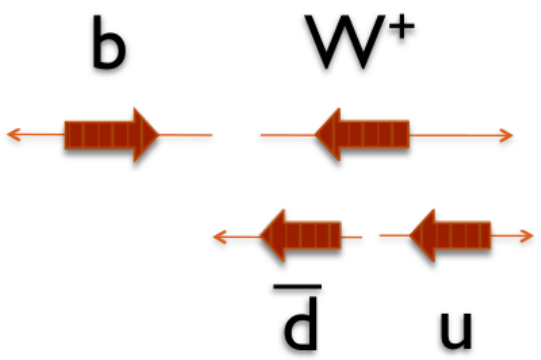
Spin correlations in $t\bar{t}$ @ CDF

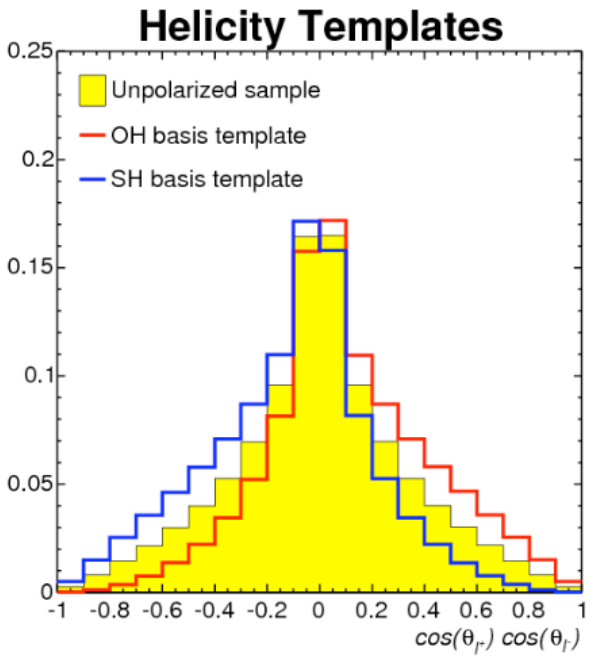


- Decay width of the top quark is shorter than the spin decoherence time
- Spin information in V-A correlations in weak decay; leptons and d quarks are best to measure this
- Top pairs with the same spin are expected to dominate sample $\kappa \approx 0.40$ in helicity basis
- Seek to evaluate expected spin correlation in QCD

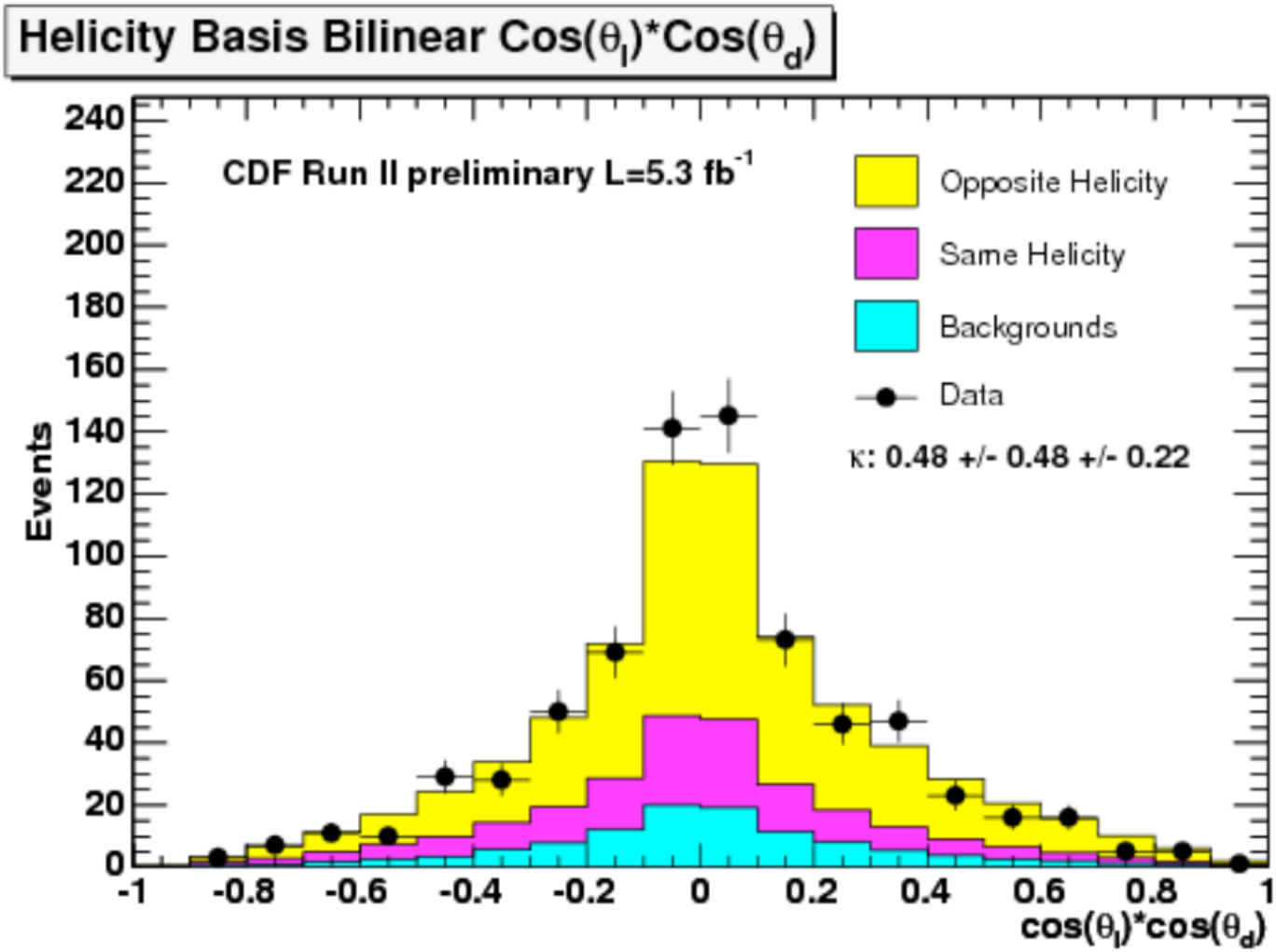
Spin correlations in $t\bar{t}$ @ CDF

- In lepton+jets channel, identify down quark as jet closest to b jet in W rest frame
- Measure cosine of lepton and down quark helicity angle
  - $\cos\theta_{lep} \times \cos\theta_d$ gives a single variable to measure the helicity of the combined $t\bar{t}$ system
- Create custom, polarized HERWIG templates for same helicity, opposite helicity, and background
- Fit product of cosines to templates using binned likelihood fit





Spin correlations in $t\bar{t}$ @ CDF



In helicity basis: $\kappa = 0.48 \pm 0.48_{stat} \pm 0.22_{sys}$

In beam basis: $\kappa = 0.72 \pm 0.64_{stat} \pm 0.26_{sys}$

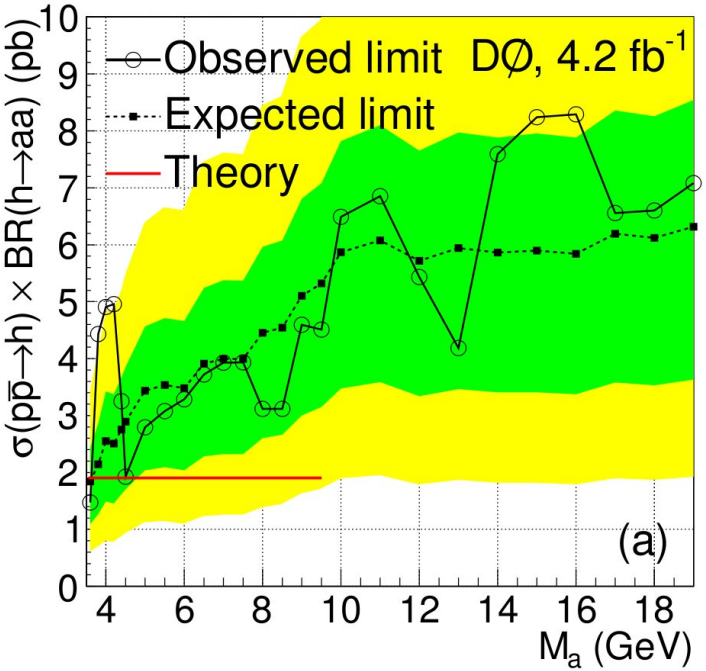
Search for nMSSM H^+ @ CDF

Motivation

- Search for $t \to H^+ b$, where $H^+ \to W^+ A$
- If $m_A < 2m_b$, $A \to \tau^+\tau^-$ will dominate
- No strong limits on A in this scenerio
- *c.f.* arXiv:0807.2135

Selection

- Start with standard $t\bar{t}$ lepton+jets selection...
- $\geq$ 3 jets, 1 b–tag, $H_T > 250$GeV
- Search for isolated track with $3 \leq p_T \leq 20$ GeV
- Dominant background from Underlying Event

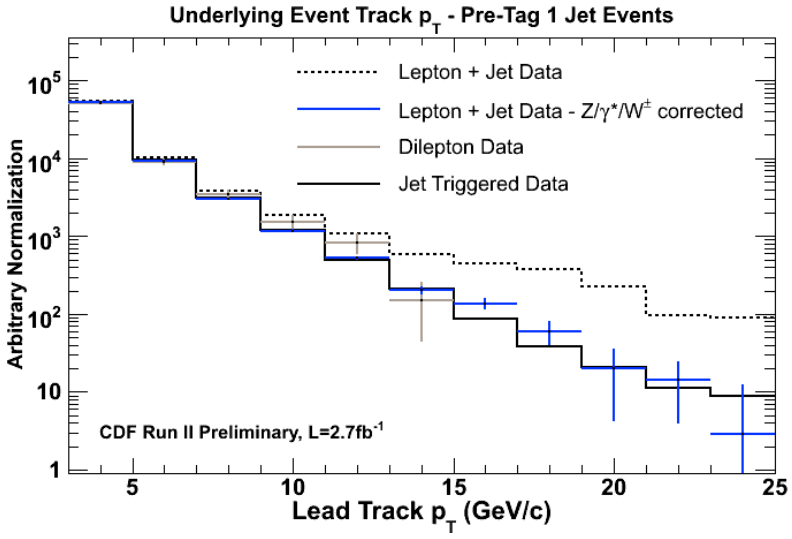


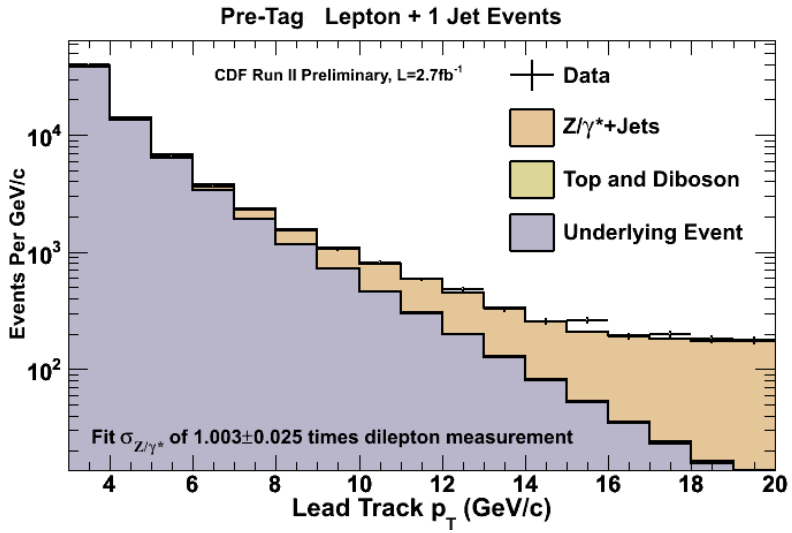
arXiv:0905.3381

Search for nMSSM H^+ @ CDF

Underlying Event Modeling

- Many samples have identical UE p_T spectra
- Jet–triggered data is used to model the UE p_T spectrum
- This model is tested by measuring the Z/γ^* cross–section
- Excellent agreement found with previous measurements

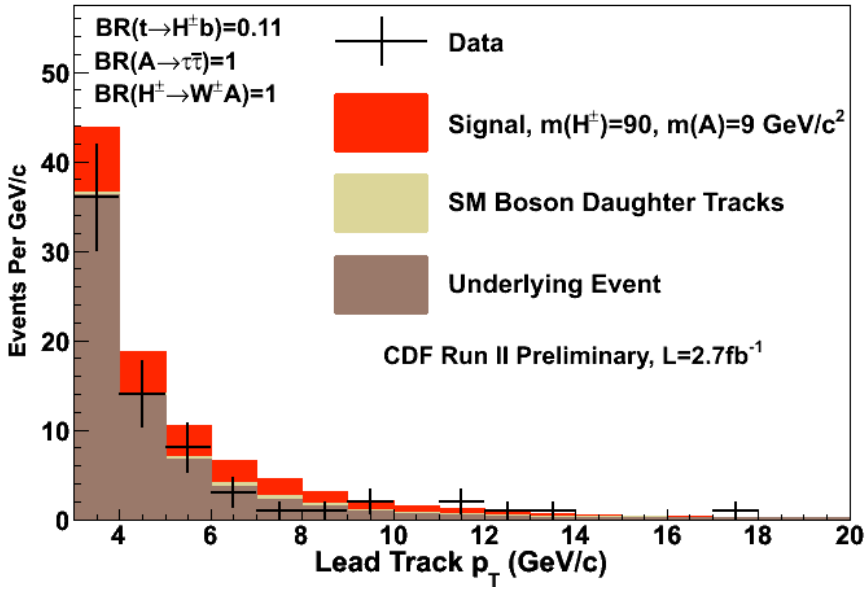


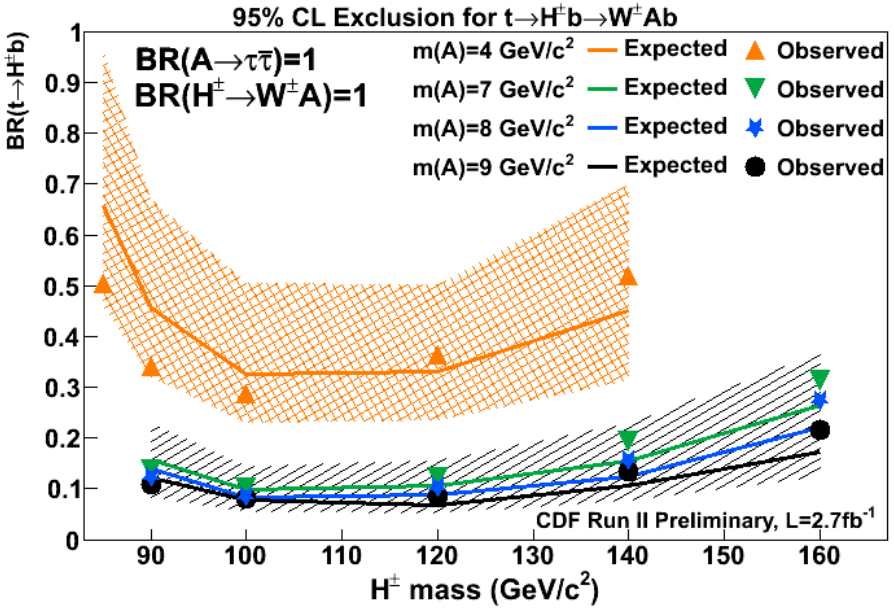


Search for nMSSM H^+ @ CDF

Results

- The data are consistent with the UE model
- But, no indication of signal
- Limits on $BR(t \to H^+ b)$ vs. m_{H^+} are set for several values of m_A

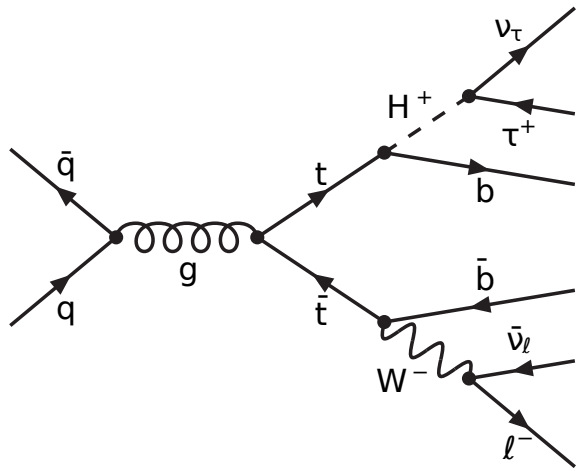


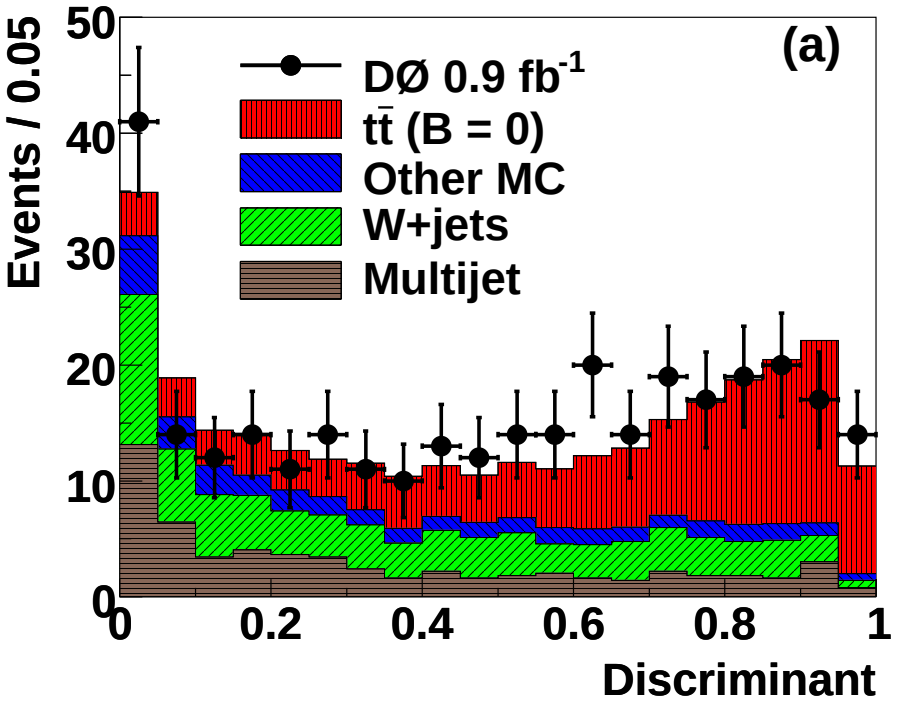


Search for MSSM H^+ @ DØ

Results

- For large $tan(\beta)$, $BR(H^+ \rightarrow \tau^+ \nu_\tau) \sim 1$
- Neural Net analysis to separate $t\bar{t} \rightarrow H^+ bW^- \bar{b}$ from $t\bar{t} \rightarrow W^+ bW^- \bar{b}$

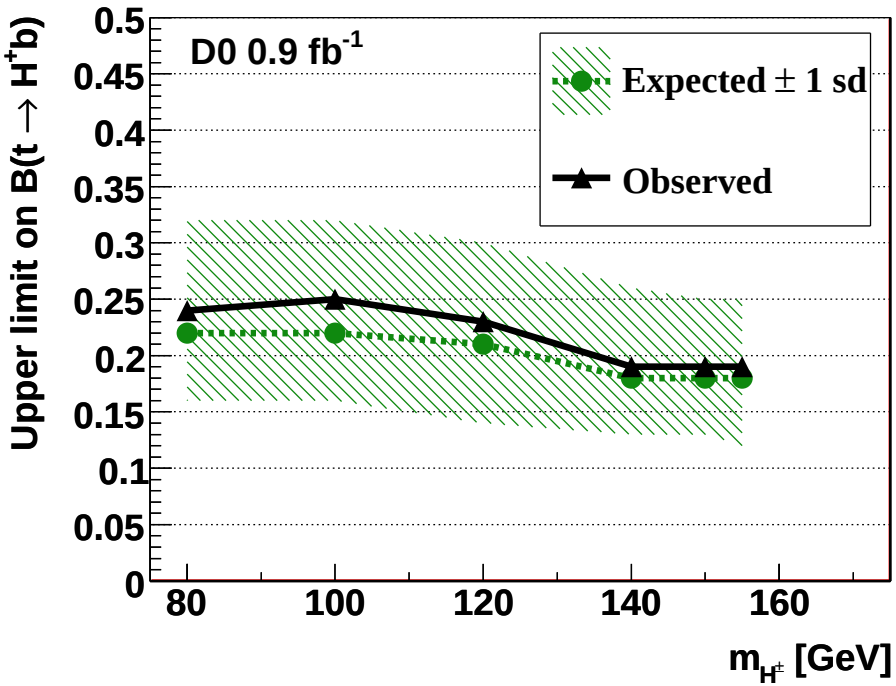


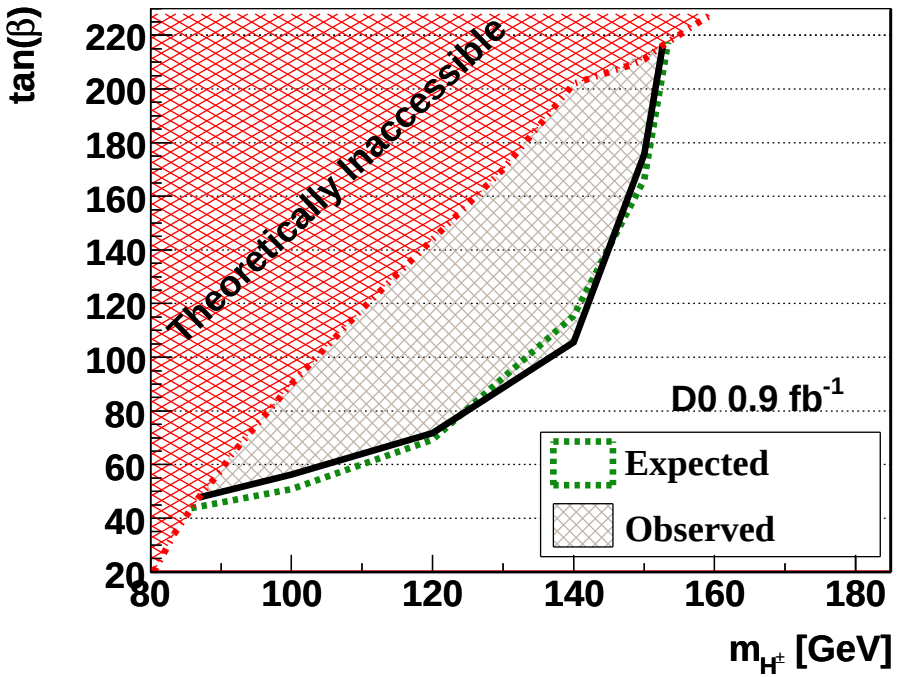


Search for H^+ @ DØ

Results

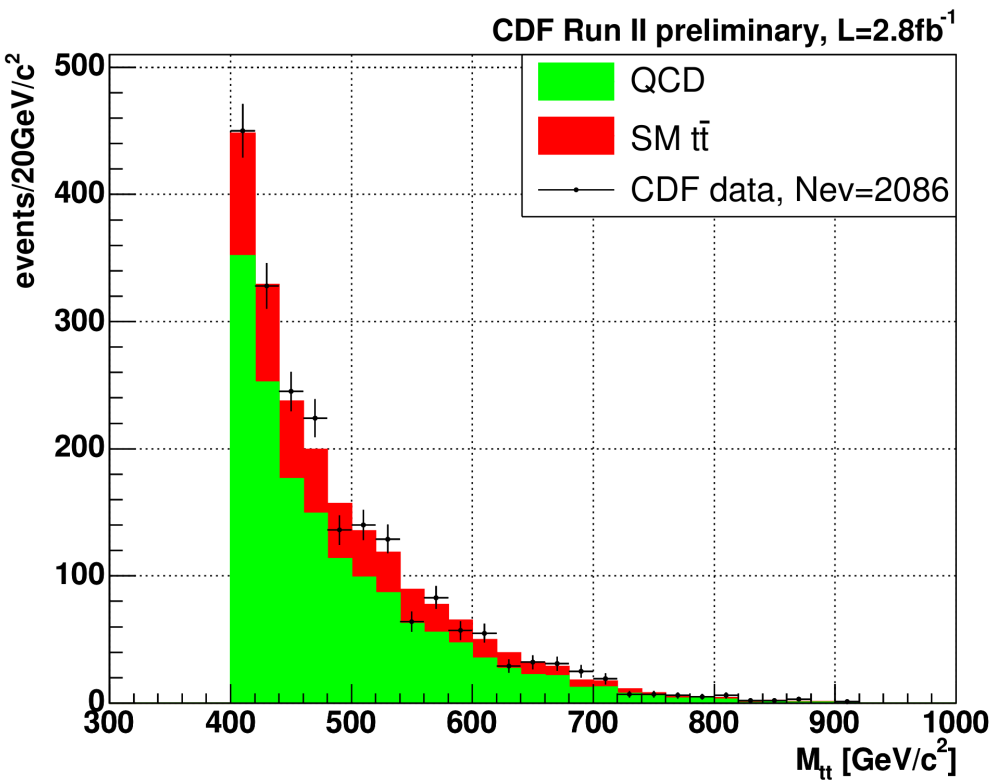
- Limits on branching–ratio, m_{H^+} vs. $tan(\beta)$

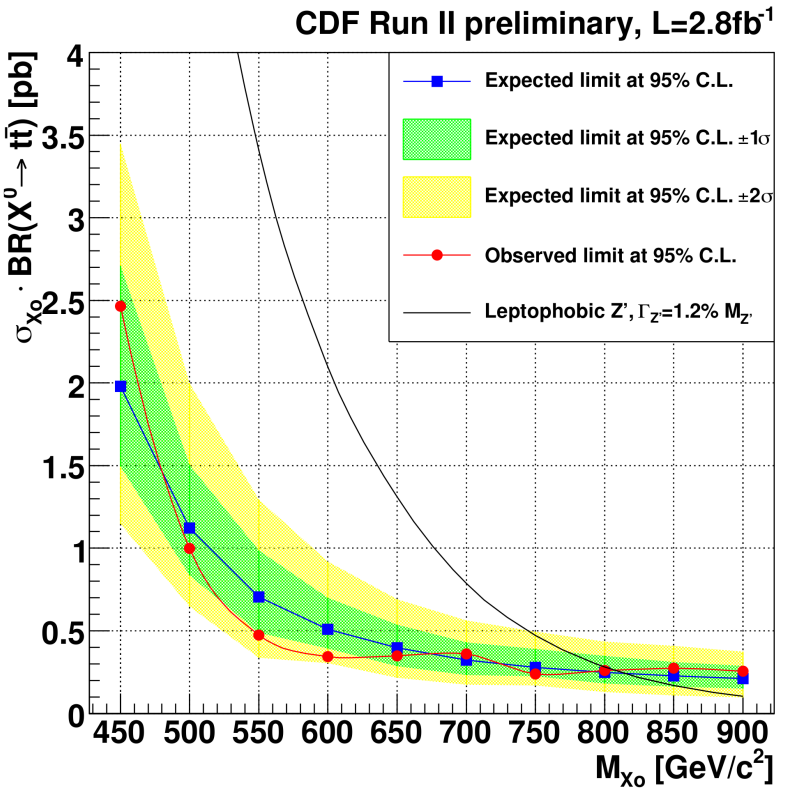




Search for resonant $t\bar{t}$ production in the all–hadronic channel @ CDF

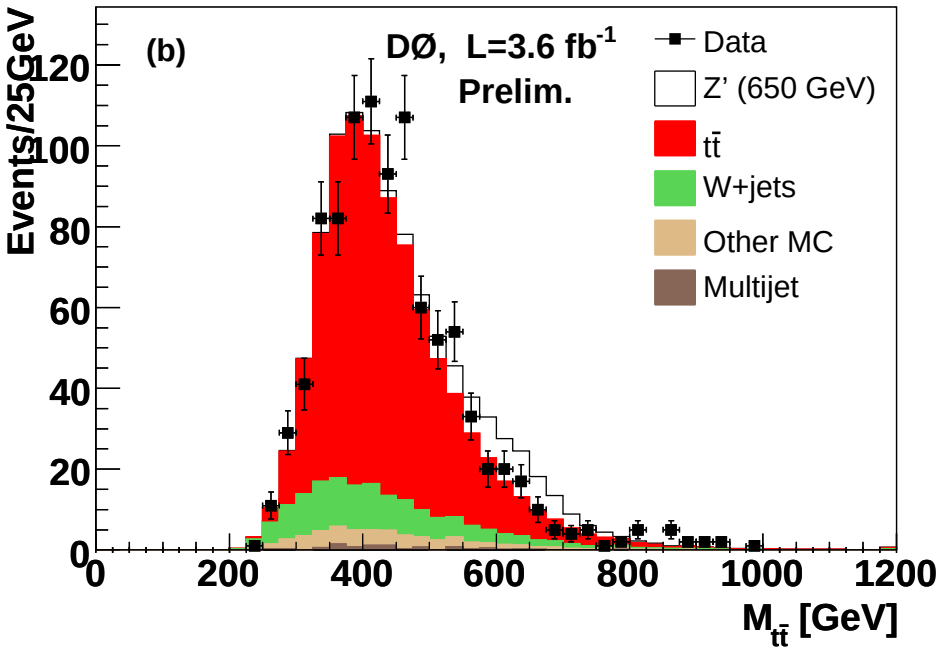
- Multijet background modeled using data.
- Event selection by Neural Net

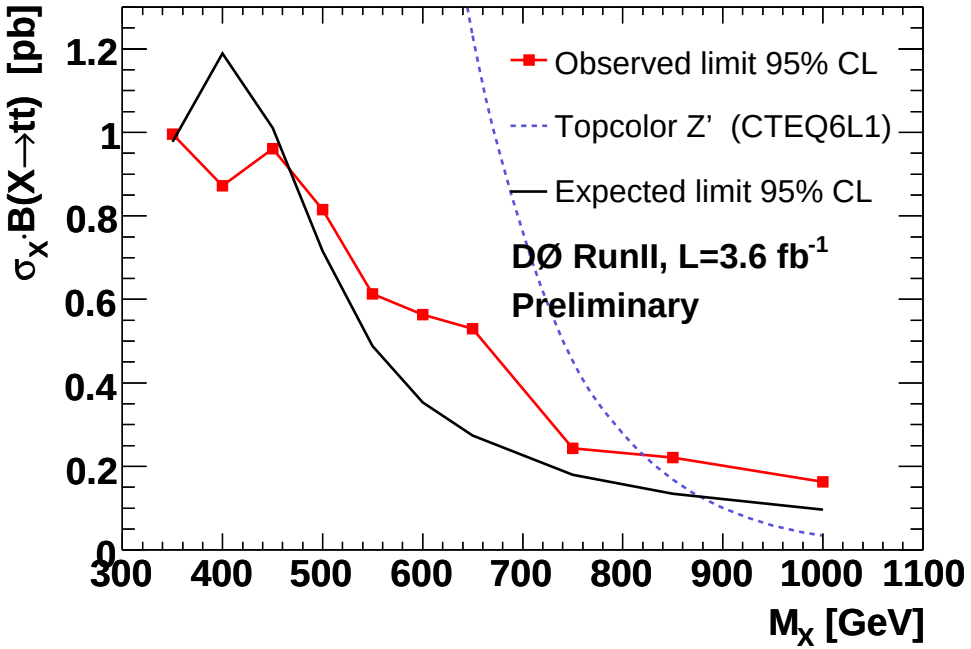




Search for resonant $t\bar{t}$ production in lepton+jets @ DØ

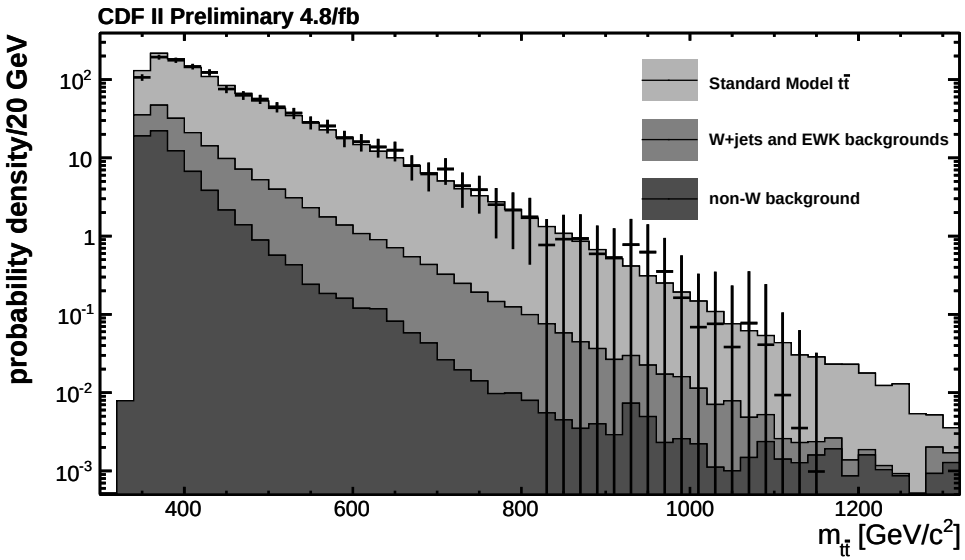
- Reconstruction simplified, robust
- 95 CL limit on top-color-assisted technicolor Z': $m_{Z'} > 820$ GeV for $\Gamma_{Z'} = 0.012 M_{Z'}$

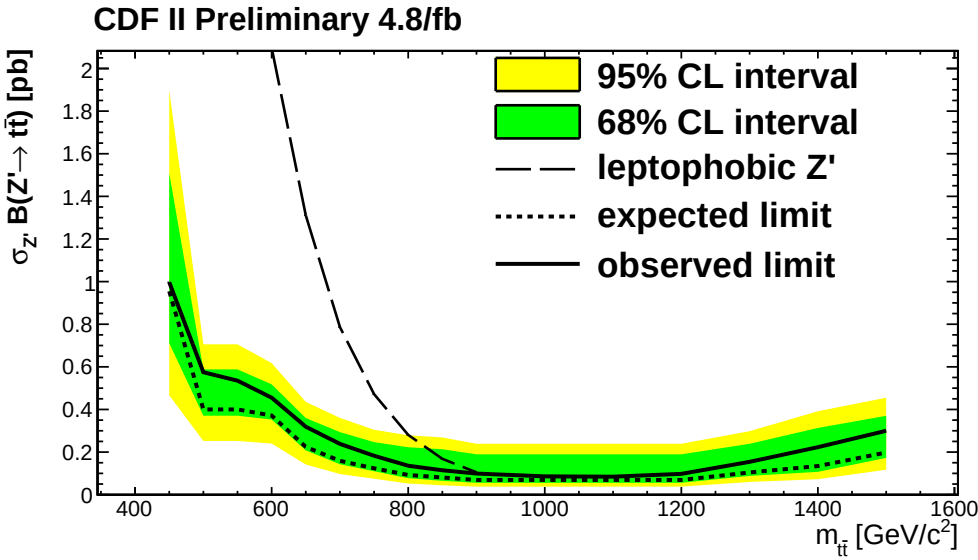




Search for resonant $t\bar{t}$ production in lepton+jets @ CDF

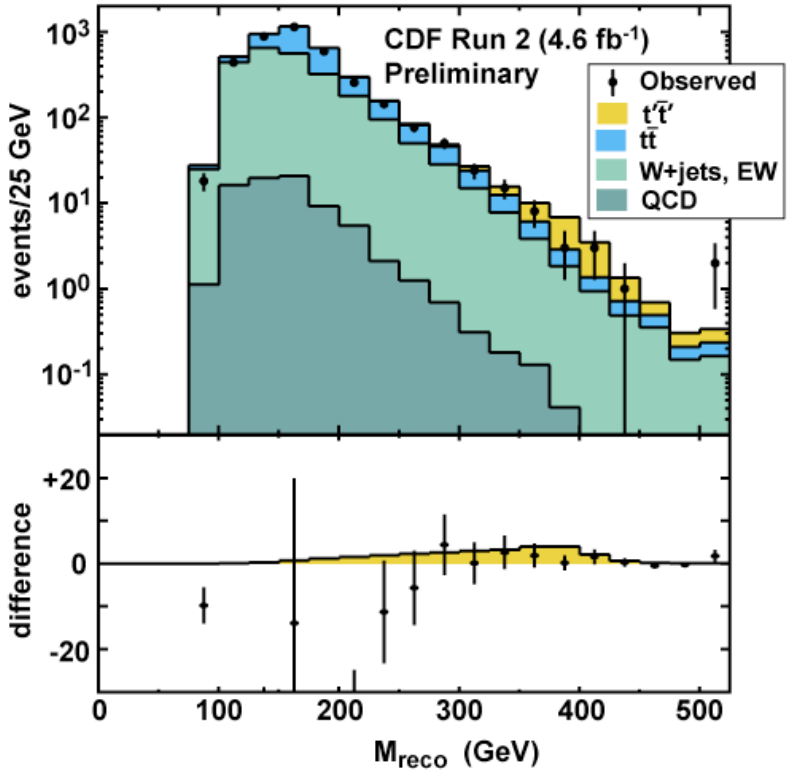
- Full Matrix Element reconstruction
- 95 CL limit on top-color-assisted technicolor Z': $m_{Z'} > 900$ GeV for $\Gamma_{Z'} = 0.012 M_{Z'}$

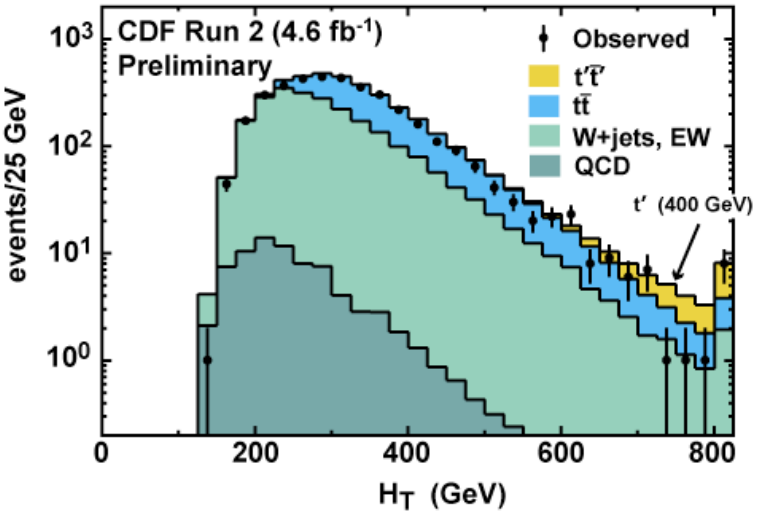




Search for t' @ CDF

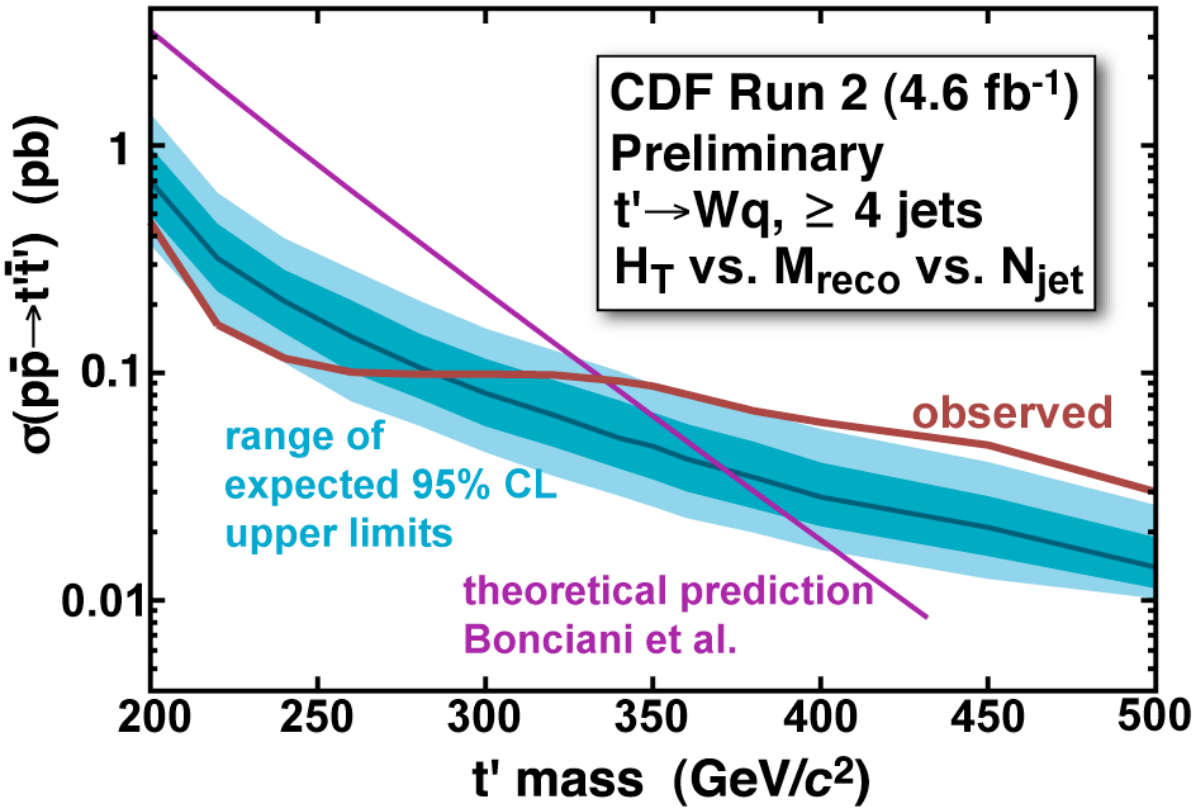
- Search for $t' \to Wq$ in lepton+jet events
- t' mass reconstructed using kinematic fit
- Fit to estimate signal cross–section in multidimensional space: H_T, M_{rec}, N_{jet}



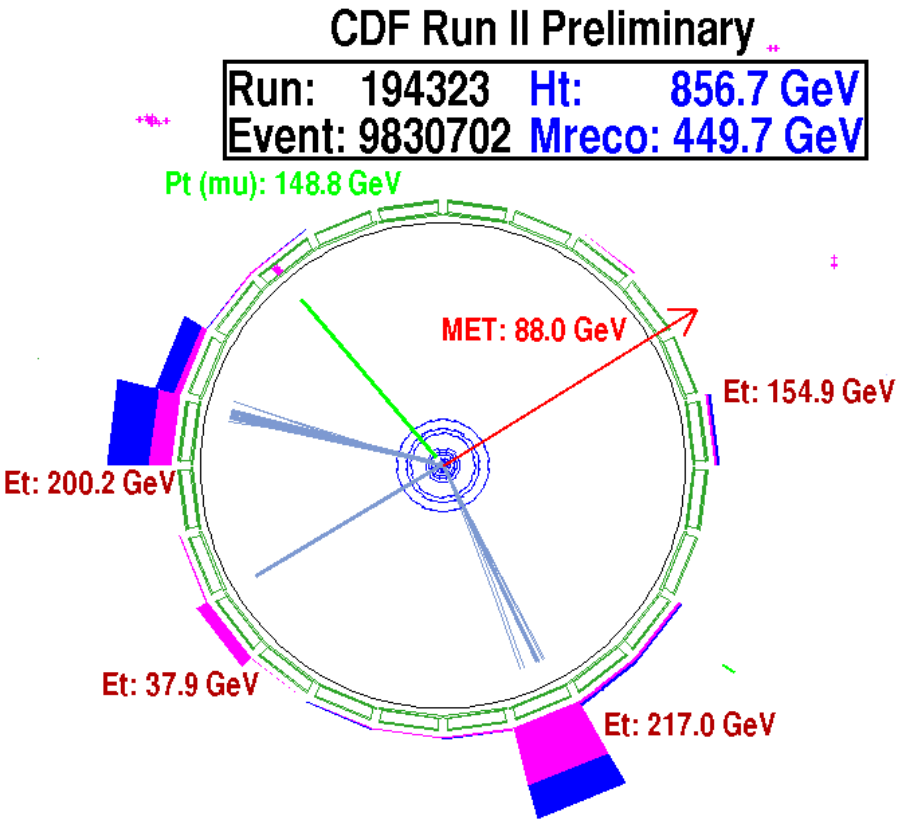


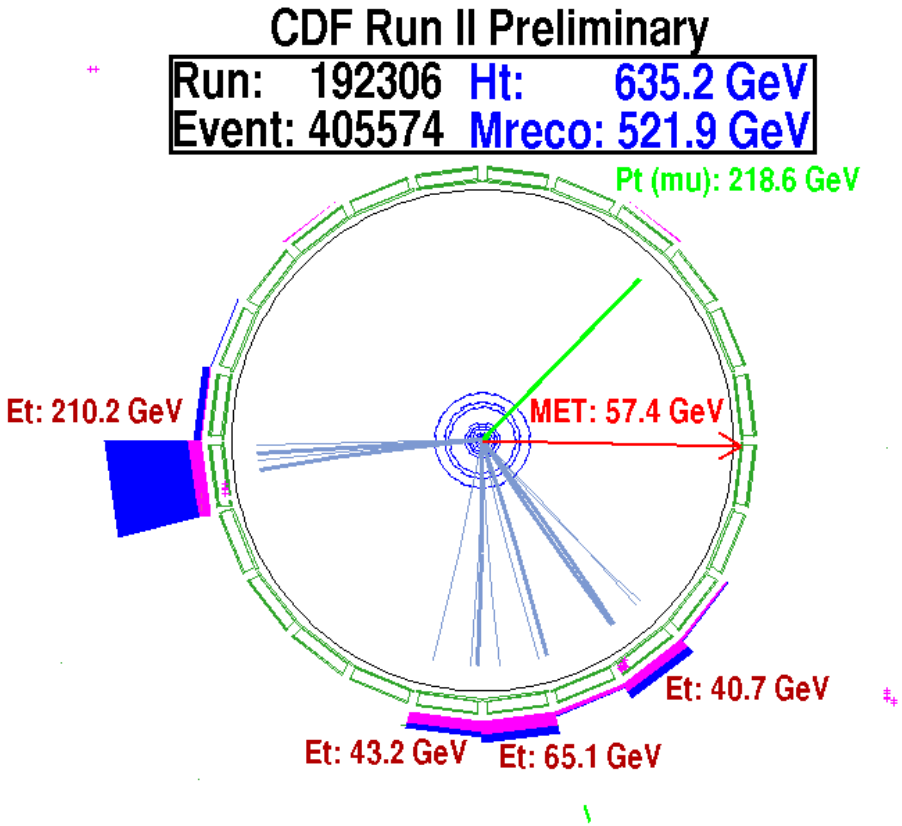
Search for t' @ CDF

- No statistically significant excess, it's really less than 2 sigma
- Events with high M_{reco} appear to be clean lepton+jet events



Event Displays of high–M_{reco} events





Thank You